SRF VACUUM SYSTEM

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Vacuum Requirements

- Vacuum pressures in cryomodule < 10^-9 torr, interlocked through valves to prevent failures from propagating from one module to another- cleanliness of components to maintain cavity performance;
- Valves must seal and minimize particulate contamination into the cavities;
- Warm beam pipe vacuum cleaned and maintained at < 10^-9 torr and interlocked to valves to minimize particulate contamination of cavities;
- Window vacuum maintained by cryo-pumping and interlocked to the RF system to minimize arcing;
- Valve status monitored and interlocked to preclude beam interception;
- Insulating vacuum not dynamically pumped but monitored to minimize cryogenic heat loads;
- DP stations provide factor of 1000 improvement in pressure between warm systems and mitigate cavity vacuum contamination.

Cryomodule, Warm Section & Vacuum Instrument Racks

Deliverables to SNS From JLab:

11 - Medium beta cryomodules with multiple vacuum systems – cavity, window, and insulating vacuum delivered in 2003;

15 - High beta cryomodules with multiple vacuum systems – cavity, window and insulating vacuum delivered in 2004;

Potentially parts for 3-6 spare high beta cryomodules and associated vacuum systems;

32 – Warm beam pipe girders 2003-4;

2 – Differential pump stations 2003-4;

~8 – Racks of ion pump power supplies, cold cathode read outs and vacuum interlocks interfaced to low level RF system and fast shut down 2003-4

Installation at SNS:

Cryomodules, warm girders, DP stations and racks 10-03 through 4-04

Commissioning at SNS:

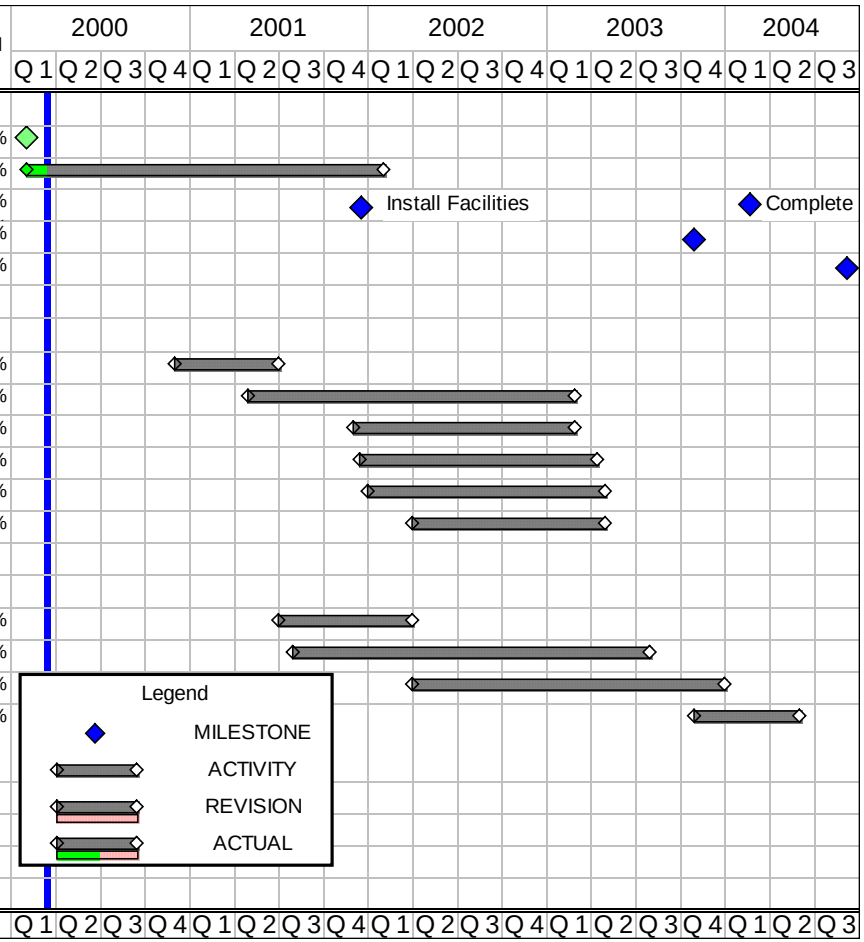
~ First units 1-04 through 5-04

Cryomodule Vacuum Documentation

- System documentation including; safety requirements, component description, engineering drawings, interface parameters;
- Electronic “travelers” used for assembly documentation;
- Electronic testing results from VTA and Acceptance testing in test cave or in accelerator.

Schedule For SC Modules & Girders

Activity Name	Start Date	Finish Date	Duration	% Complete
MILESTONES				
START SRF PROGRAM	2/1/00			100%
CM PROTOTYPING EFFORT	2/1/00	2/1/02	24	5%
BOD SRF INFRASTRUCTURE BD.	12/18/01			0%
COOLDOWN W/ KINNEY PUMP	11/1/03			0%
1 GeV BEAM	9/7/04			0%
SNS CAVITIES				
CAVITY RFP('S)	12/1/00	7/1/01	7	0%
CAVITY FABRICATION	5/1/01	3/1/03	22	0%
CAVITY DELIVERY	12/1/01	3/1/03	15	0%
CAVITY PROCESSING	12/15/01	4/15/03	16	0%
CAVITY TESTING	1/1/02	4/30/03	16	0%
CAVITY FINAL PROCESSING	4/1/02	4/30/03	13	0%
SNS CRYOMODULES				
CM PARTS RFP'S	7/1/01	4/1/02	9	0%
CM PARTS FAB	8/1/01	8/1/03	24	0%
CM FABRICATION & ASSEMBLY	4/1/02	1/1/04	21	0%
CM CHECKOUT AND COMMISS.	11/1/03	6/1/04	7	0%



Vacuum Racks

SLIDE 6

IN

SEE

Final Design Review 7-26-00

PORTRAIT

Vacuum System Racks

- Jlab provides individual power supplies located in the klystron service building with a HV cable down into each ion pump in the tunnel;
- Each warm girder and each cryomodule has an ion pump;
- Each can on the differential pumping station has a non-evaporable getter and an ion pump;
- All vacuum interlocks are located in the crates in the service building;
- All RF or beam interlocks must respond fast enough ~ few ms to obviate cavity damage;
- Each cryomodule has an insulation vacuum ion gauge powered and read out in the vacuum racks;
- Each cavity has a coupler vacuum ion gauge (cold cathode) powered and read out in the vacuum racks.

RF Racks in Service Building

SLIDE 8

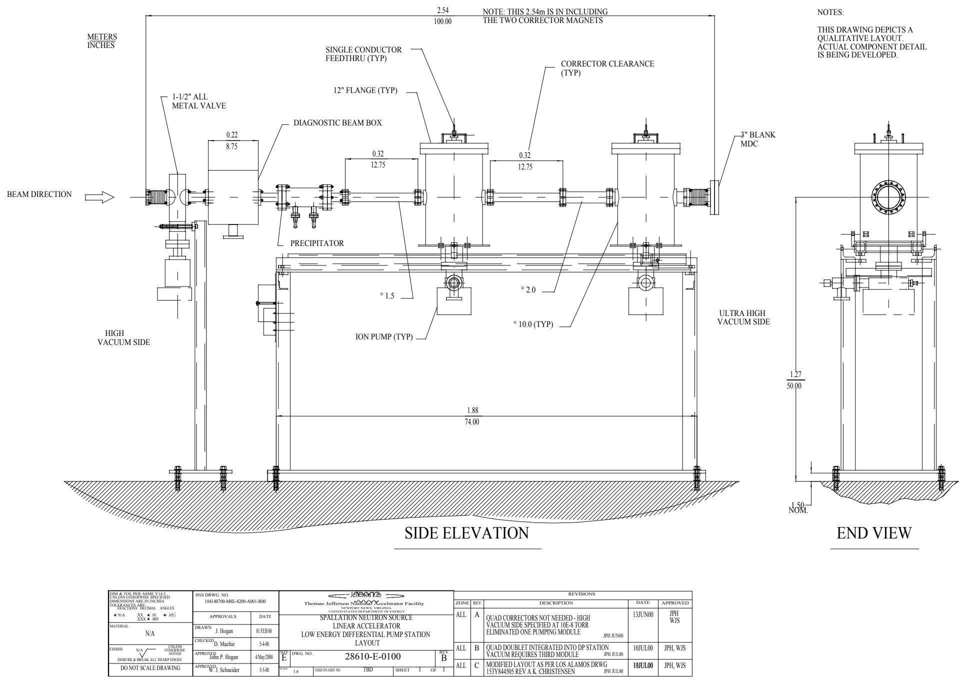
IN

SEE

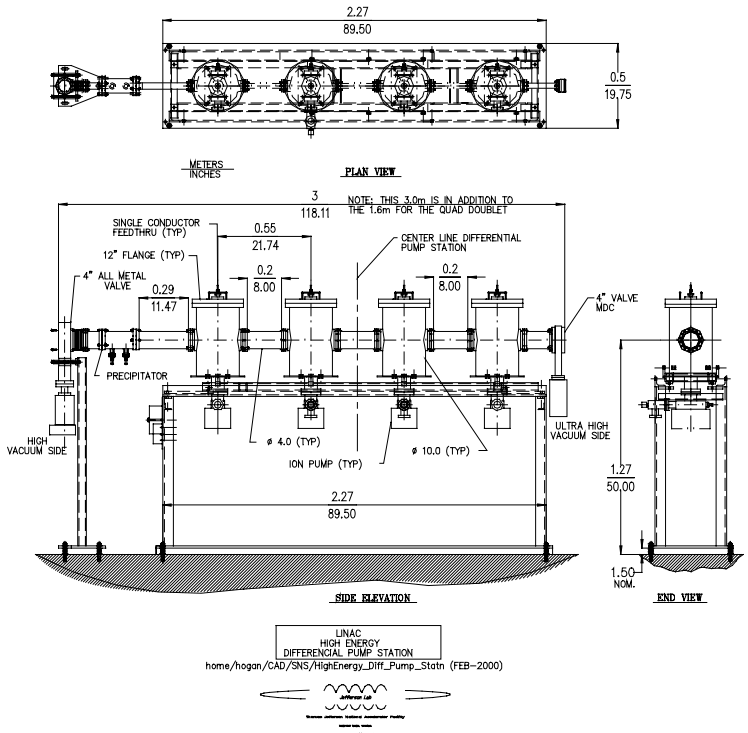
Final Design Review 7-26-00

PORTRAIT

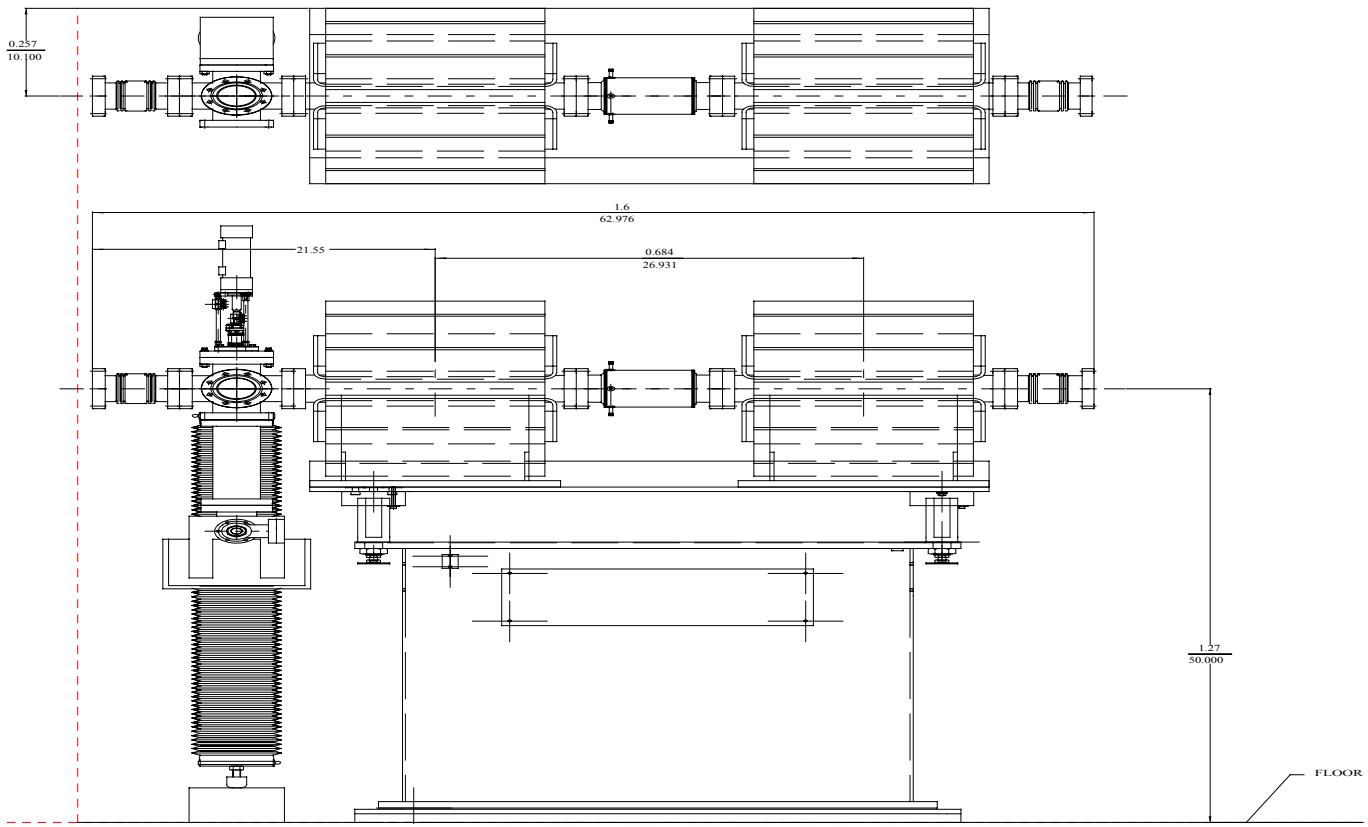
LE Differential Pump Station



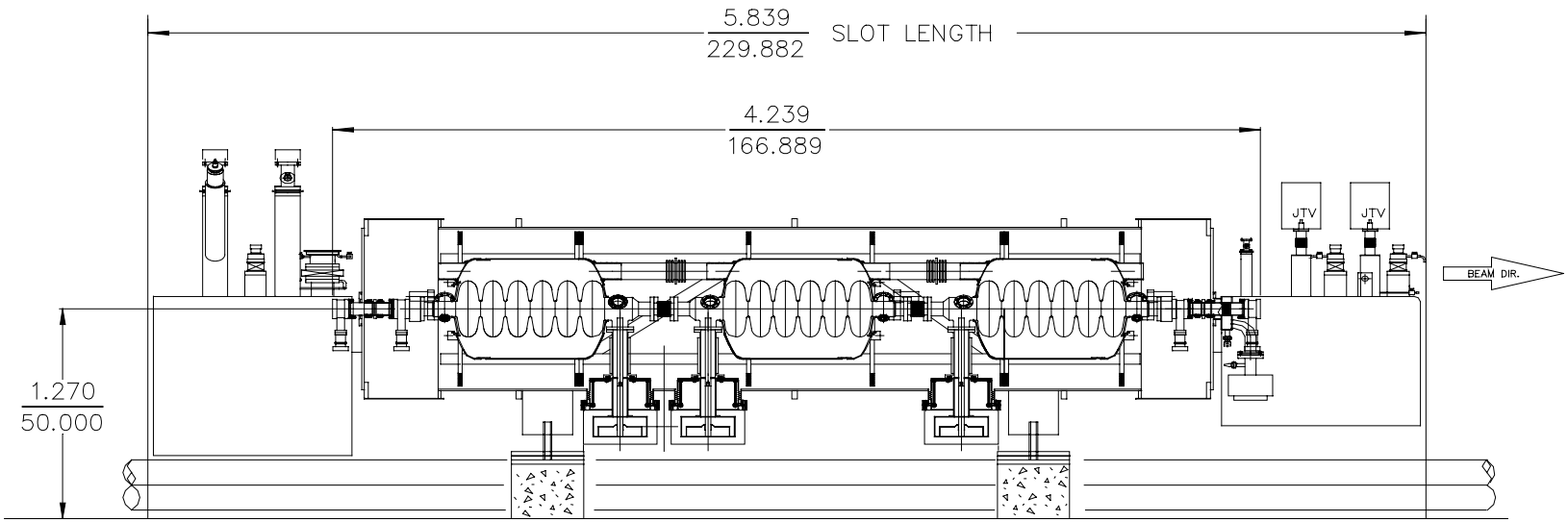
HE Differential Pump Station



1.6 m Warm Region Girder



SNS Medium Beta Cryomodule



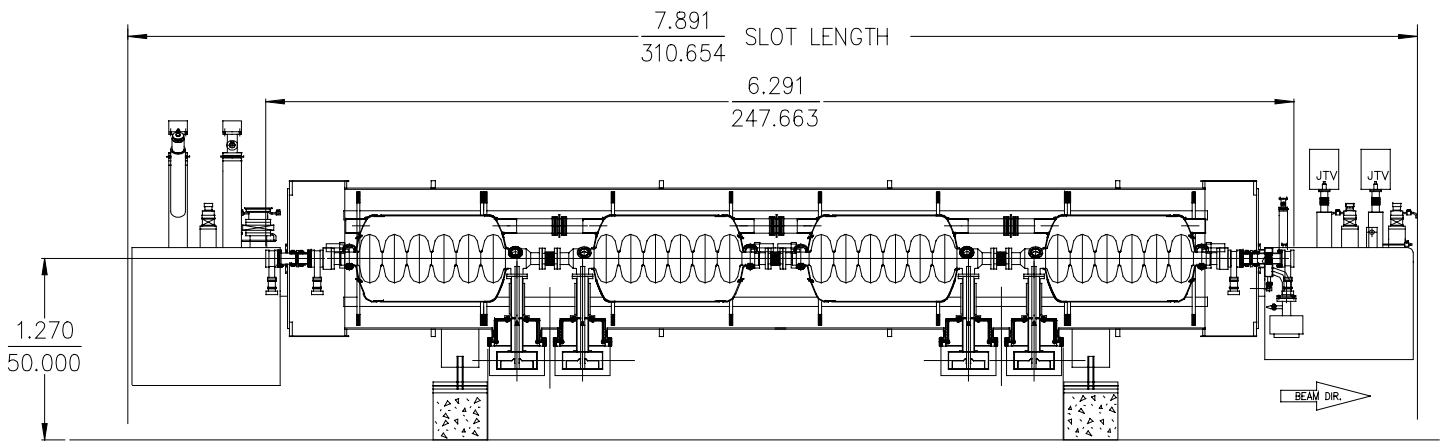
Cryomodule & Warm Beam Pipe

- Cryomodules are shipped to SNS on a flat bed air ride trailer using a special support structure and can be delivered to the tunnel or storage;
- They can be shipped with either static or dynamic pumping, if shipped to storage under static vacuum, facility will need vacuum support to re-establish beamline ion pumps;
- Insulating vacuum space will be vented to GN2, Helium circuits will be at positive pressure helium and monitored;
- SNS will need a 5 ton crane to unload cryomodules from the truck;
- To move a module within the tunnel or around the SRF facility , a set of wheels are bolted to the cryomodule stands which allows movement;
- Final alignment is accomplished using SNS alignment personnel.

Cryomodule Warm Beam Pipe (cont'd)

- Supports for the girders and the LE DP station are by LANL. Diagnostics are supplied by LANL to Jlab and incorporated into the warm beam pipe. Magnets from LANL are shipped separately. Alignment is accomplished during assembly;
- Assembly of the warm beam pipe on the girder and installation of magnets takes place at SNS using a mandrel and fiducials;
- Girders are brought into the tunnel on an electric fork lift;
- Girder installation occurs after cryomodule final alignment;
- Cryomodule and girder operational checks are performed including checkout of the vacuum interlock crate.
- Test equipment will be used to automatically checkout interlocks and functionality.

SNS High Beta Cryomodule



LOW ENERGY DIFFERENTIAL PUMP

Component	Vendor	Description		Quantity
Ion Pump	Physical Electronics	40 l/s		3
Power Supply	Custom FNAL	5kV-70mA		1
Precipitator				1
Power Supply	Physical Electronics	IONPAK		1
All Metal Valve (1.5")	VAT			1
Actuator Control		Low Voltage Signal		1
Pneumatic Valve (3")	VAT			1
Actuator Control		Low Voltage Signal		1
Convectron Gage	Granville-Phillips	Low Voltage Signal		1

HIGH ENERGY DIFFERENTIAL PUMP

Component	Vendor	Description		Quantity
Ion Pump	Physical Electronics	40 l/s		4
Power Supply	Custom FNAL	5kV-70mA		1
Precipitator				1
Power Supply	Physical Electronics	IONPAK		1
All Metal Valve (3")	VAT			1
Actuator Control		Low Voltage Signal		1
Pneumatic Valve (3")	VAT/MDC			1
Actuator Control		Low Voltage Signal		1
Convectron Gage	Granville-Phillips	Low Voltage Signal		1

CRYOMODULES & WARM BEAM PIPE

Component	Vendor	Description		Quantity
Ion Pump - Beamline	Physical Electronics	40 l/s		32
Power Supply	Custom FNAL	5kV-70mA		32
Ion Pump - Warm Sectio	Physical Electronics	40 l/s		33
Power Supply	Custom FNAL	5kV-70mA		33
Beamline Valve (3")	VAT	Low Voltage Signal		64
Convectron Gage	Granville-Phillips	Low Voltage Signal		32

Cryomodule Acceptance Test

- Position completed cryomodule in the tunnel;
- Install U-tubes and perform other cryomodule hook-up;
- Make Cable connections for controls and interlocks;
- Cool down cryomodule
- Perform RF cable calibrations cold
- Perform acceptance testing of cryomodule;
  - Interlock check out
  - Max Gradient and limiting parameter and HP condition of couplers;
  - Gradient vs. Qo; need self excited loop or VCO
  - Qext Power Coupler and Field Probe
- Measure Static heat loads;
- Operation in linac.

Vacuum System Summary

- Vacuum pressures in cryomodule are normally low < 10^-12 torr due to 2K surfaces, interlocked to prevent failures from propagating from one module to another;
- Valves must seal and minimize particulates into the cavities;
- Warm beam pipe vacuum cleaned and maintained at < 10^-9 torr and interlocked to valves to minimize particulate contamination of cavities;
- Window vacuum monitored and interlocked to the RF system to minimize arcing;
- Valve status monitored and interlocked to FSD to preclude beam interception;
- Insulating vacuum monitored to minimize cryogenic heat loads;
- DP stations provide factor of 1000 improvement in pressure and mitigate cavity vacuum contamination.